

Table 2-3 Available Substitute Topsoil Material

Location	Drill Hole	Drill Depth (in)	Area (acres)	Volume Available (cu. yd)	Minimum Cut Depth (in)
TS-3	SEDB-1	24	.09	296	13
TS-3	SEDB-2	48	.09	602	13
TS-3	SHP-1	60	1.34	10,797	13
TS-3	SHP-2	60	.81	6,533	13
TS-3 Totals			2.33	18,228	
TS-4	SEDA-1	24	.24	777	2.5
TS-4	SEDA-2	24	.20	641	2.5
TS-4 Totals			.44	1,418	
TS-5	SP-1	18	.69	1,680	18
TS-5	SP-2	24	.36	1,150	24
TS-5	CSP-1	96	.95	12,292 12,190	30
TS-5	CSP-2	84	1.32	14,903 14,863	27
TS-5	CSP-3	72	.25	2,459 1,931	27
TS-5	CSP-4	60	1.67	13,477 13,469	27
TS-5	CSP-5	72	3.03	29,325	27
TS-5 Totals			8.28	75,286 74,608	
TS-6	PAR-1	84	2.62	29,589	12
TS-7	LHP-1	96	1.73	22,329	12
TS-8	USP-1	120	.87	14,036	12
TS-9	REF-1	36	.26	1,253	18
TS-9	REF-2	36	.71	3,413	18
TS-9	REF-3	36	.23	1,122	18
TS-9 Totals			1.20	5,788	

The proposed substitute topsoil material will be re-tested in the final five years of operations according to Table 5O-1 and will include Total Petroleum Hydrocarbons by EPA Methods 8015 and 418.1. The location of these samples will correlate with the areas generating the most substitute topsoil material as described in Appendix 5-I. Following regrading, soils remaining on the surface as substitute topsoil material will be sampled for pH, EC, and Total Hydrocarbons by EPA method 8015 for diesel fuel and 418.8 for waste oil.

Table 2-8 Substitute Topsoil Summary

Location	Topsoil Amounts Required			Substitute Topsoil Generated from Cuts (cu. yd.)			
	Area (acres)	Depth (in.)	Volume (cu. yd.)	Topsoil Stockpile	Sub. Topsoil Generated	Sub. Topsoil Not Regraged	Total Topsoil
TS-3	1.41	12	2,275	0	2,080	2,563	4,643
TS-4	.75	10	1,008	0	1,008	0	1,008
TS-5	9.41	12	15,181	0	21,492 <i>20,814</i>	4,537	26,029 25,361
TS-6	3.25	12	5,243	0	7,111	0	7,111
TS-7	1.81	12	2,920	0	4,170	0	4,170
TS-8	.83	12	1,339	0	3,552	0	3,552
TS-9	1.83	12	2,952	1,200	3,761	0	4,961
Total			36,452				51,842 <i>50,796</i>

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CHAPTER 5 ENGINEERING

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Primary Haul Road

The Bear Canyon Haul Road is approx 3690 ft long from the gate to the base of the Portal Access Road and Tipple Access Road. See Plates 5-2 and 5-4. As shown on Plates 5-2, this portion of the road is included in the Permit Area. This Primary road is constructed approximately 30 ft wide and is surfaced with 4 in. minimum of ~~road-base~~ pavement material. Approximately 160 ft of the road adjacent to the scalehouse is to be surfaced with 6 in. of pavement. Installation of the black top will involve hauling in a hot mix from a local asphalt plant and laying it on the road. The road is crowned in the middle except in the load-out area where it slopes towards center drains as shown on the cross section, Plate 5-4.

Reclamation of this portion of the Bear Canyon Road will occur at approx the same time as the final removal of the sedimentation ponds and diversions on the mine site. Removal of the asphalt on this road will consist of hauling the material to a landfill approved for solid waste disposal and/or recycling of the material in cooperation with a local asphalt plant. The road will be narrowed, but will remain in place for the post-mining land use.

SUBSTITUTE TOPSOIL MATERIAL

The substitute topsoil material that will be used is included in the cut volumes. Chapter 2, R645-301-224, describes the source of all substitute topsoil and it's use during reclamation.

CUT AND FILL VOLUMES

Areas TS-3, TS-4, and TS-9 will balance within themselves and no material will be hauled in or out of the Areas. Fill material generated in Areas TS-5 and TS-6 will be hauled to Areas TS-7 and TS-8 and the four areas will balance together. A total additional volume of 14,948 cu. yd. will be needed in TS-7 and TS-8. During the Wild Horse Ridge construction 1,000 cu. yd. of material was hauled to the area as described on page 5K-7. During the load-out expansion 678 cu. yd. of material was hauled to the area giving a remaining volume of 13,270 cu. yd.

Cut and fill volumes were measured using "Quicksurf" Version 4.0 3-D modeling software package, copyright 1991, Schreiber Instruments, Inc. Volumes are based on the contours on Plates 5-6 and Plates 5-2. Quicksurf was also used to generate the cross-sections which were then used to calculate the amount of substitute topsoil that was generated with each of the cuts.

Table 5I-1 shows the summarized cut and fill volumes for each section. The following pages show detailed cut and fill tables as well as cross-sections for each area. Plates 5-6 and 2-3 show the location of the cross-sections for areas TS-3 through TS-9. R645-301-240 describe the topsoil depths and there sources.

**Table 5I-1 - Cut and Fill Summary
Areas TS-3 Through TS-9**

Area	Fill (-) Volume (cu. yd.)	Cut (+) volume (cu. yd.)	Excess Volume (cu. yd.) ¹
TS-3	1,454	1,468	14
TS-4	3,460	3,473	13
TS-5	25,157	40,585 <u>39,907</u>	15,428 <u>14,750</u>
TS-6	5,573	8,126	2,553
TS-7	18,037	6,445	-11,592
TS-8	7,022	3,666	-3,356
TS-9	5,851	5,889	38
Cumulative Balanced Volume (cu. yd.) =			3,098 <u>2,420</u>

¹ An excess volume of 3,098-2,420 cu. Yds. will be generated based on the contours shown on Plates 5-6. This excess is generated in Reclamation Area TS-5, and demonstrates that there is adequate material for reclamation. During reclamation, actual contours in TS-5 can be varied in the areas of cut to eliminate this excess cut. This excess material may also be used to cover any soil found to be unsuitable at the time of reclamation.

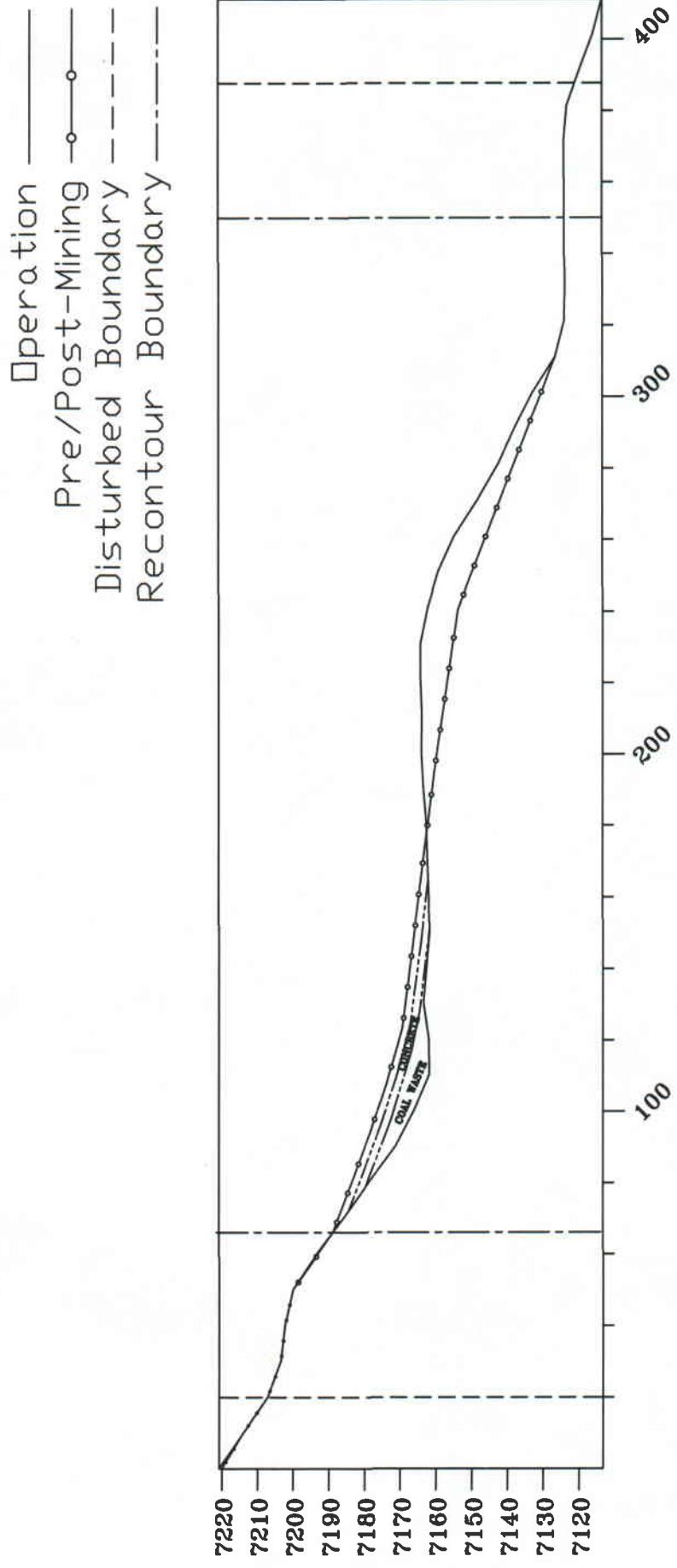
Table 5I-4 - Area TS-5 Cut & Fill Summary

Section	Min. required ¹	Fill (-) Volumes (cu. Yd.)			Cut (+) Volumes (cu. yd.)			Volume Cumulative (cu. yd.)	
		Soil	Coal Waste / Sediment	Concrete	Total Fill Volume ²	Substitute Topsoil	Other Soil	Coal Waste / Sediment	Total Cut Volume
0+00	0	89	0	0	89	304	407	0	711
1+00	0	44	0	0	44	1,148	3,311	0	4,459
2+00	452	690	0	210	690	452	100	0	5037
3+00	385	596	209	325	805	359	189	0	4899
4+00	741	1,182	813	590	1,995	2,354	0	412	542 548
					2,335	2,747			5410 5,394
5+00	504	2,316	411	433	2,737	6,244	3,457	1,095	10,796
					6,200	10,752			13,404
6+00	1,295	1,322	430	644	1,752	3,246	552	1,210	5,008
					3,195	4,957			16,725
7+00	740	989	137	400	1,126	359 325	0	1,004	1,363
					359	1,329			16,614
8+00	911	1,326	2,726	763	4,052	4,937	892	1,278	1,362
					1,926	4,096			16,817
9+00	3,481	5,145	2,724	3,548	7,869	3,193 3,114	1,319	2,105	6617 6,538
					3,193	4,096			15,765 15,530
10+00	452	630	667	440	1,297	923 597	32	775	4730 1,404
					1,297	4,096			16,198 15,637
11+00	415	1,041	0	274	1,041	303 186	0	305	608 491
					1,041	186			15,765 15,087
12+00	430	755	0	293	755	429	90	0	519
					755	519			15,529 14,851
13+00	480	838	67	121	905	244	560	0	804
					905	804			15,428 14,750
Totals		16,973	8,184	8,041	25,157	21,492	10909	8,184	40,585
						20,814			39,907

¹ These volumes represent the minimum volume of soil which is required in order to cover the coal waste and concrete material to show that the fill volumes being placed are adequate to cover the coal waste and concrete material.

² Fill volumes do not include concrete volumes since concrete disposal on site is provided in separate bond calculations. The volumes are provided here to account for the volumes shown on the cross-sections.

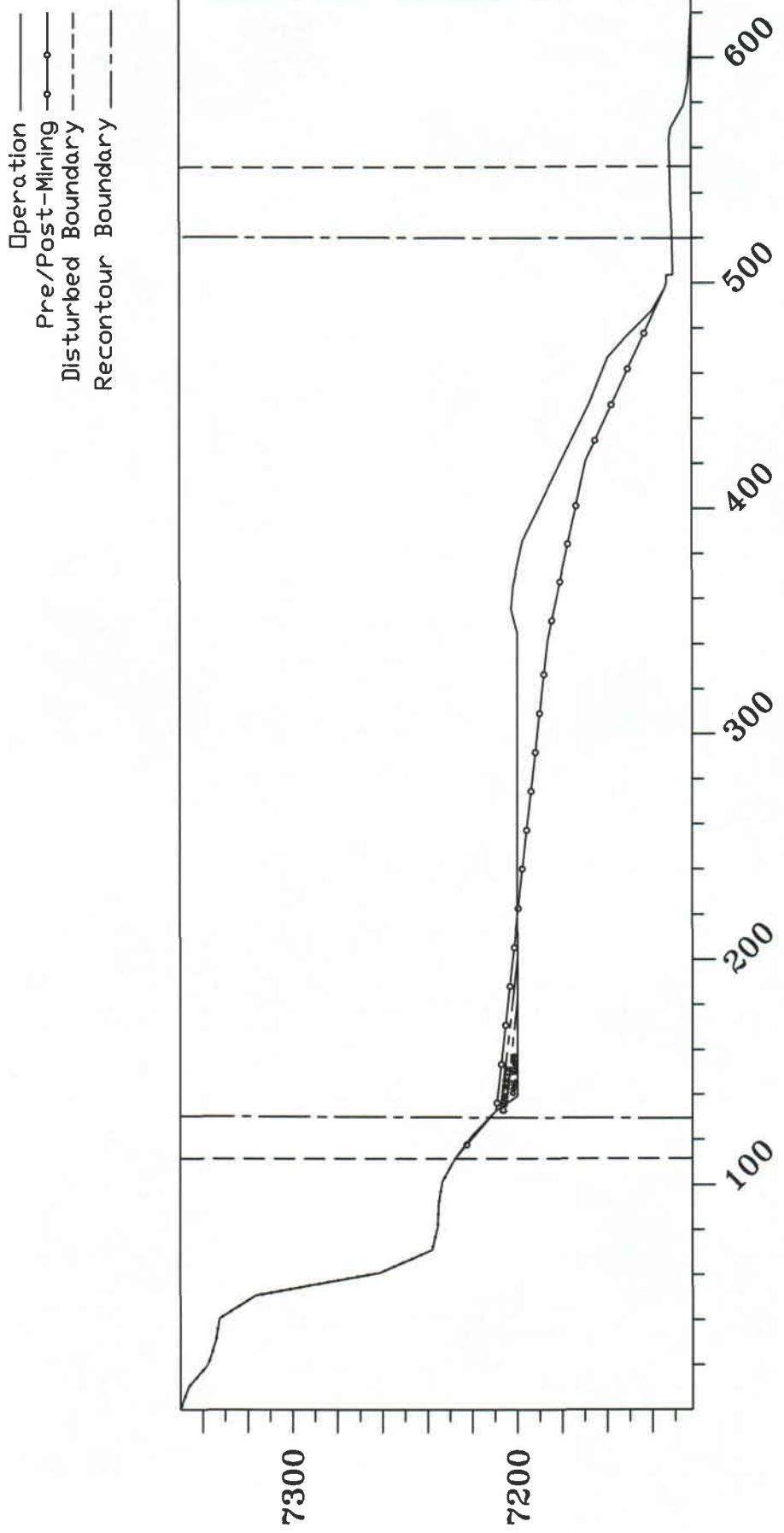
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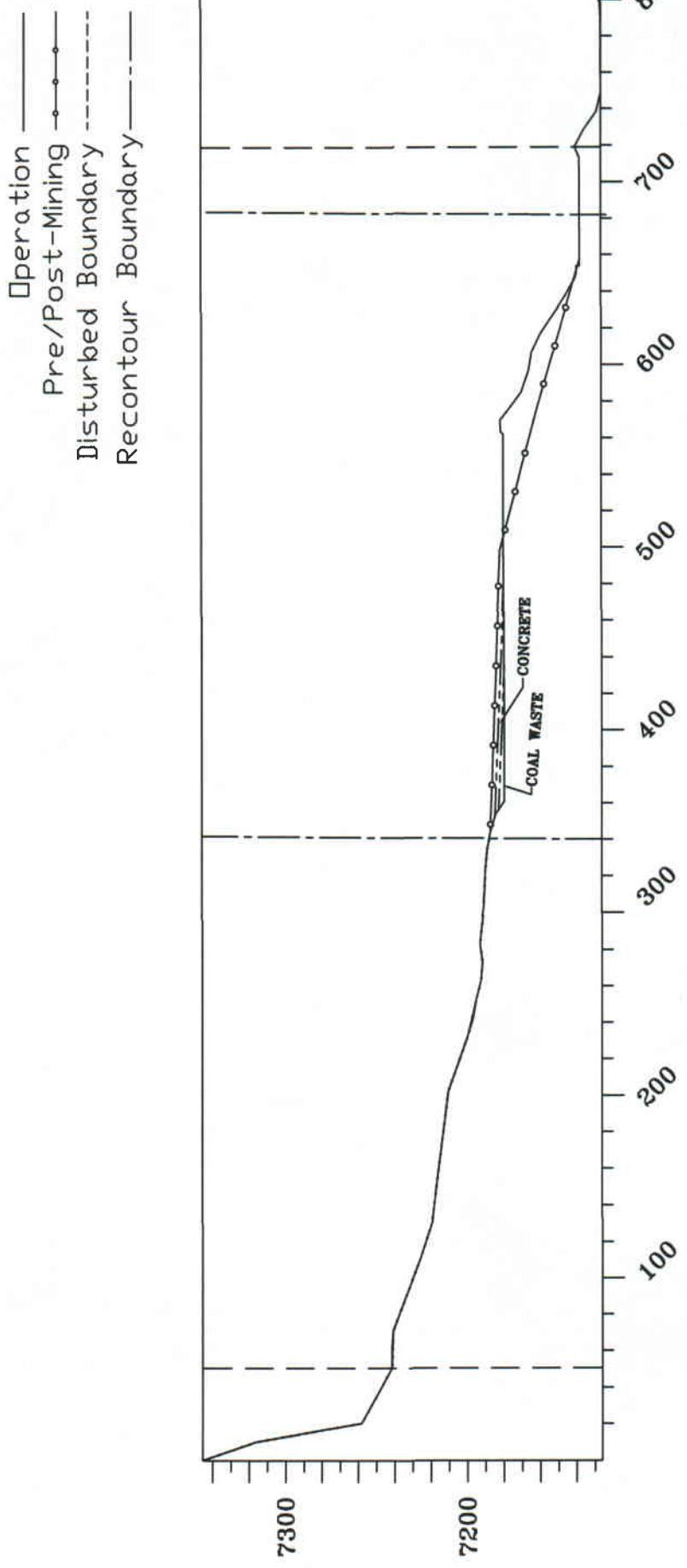
TS-5 Section 5+00



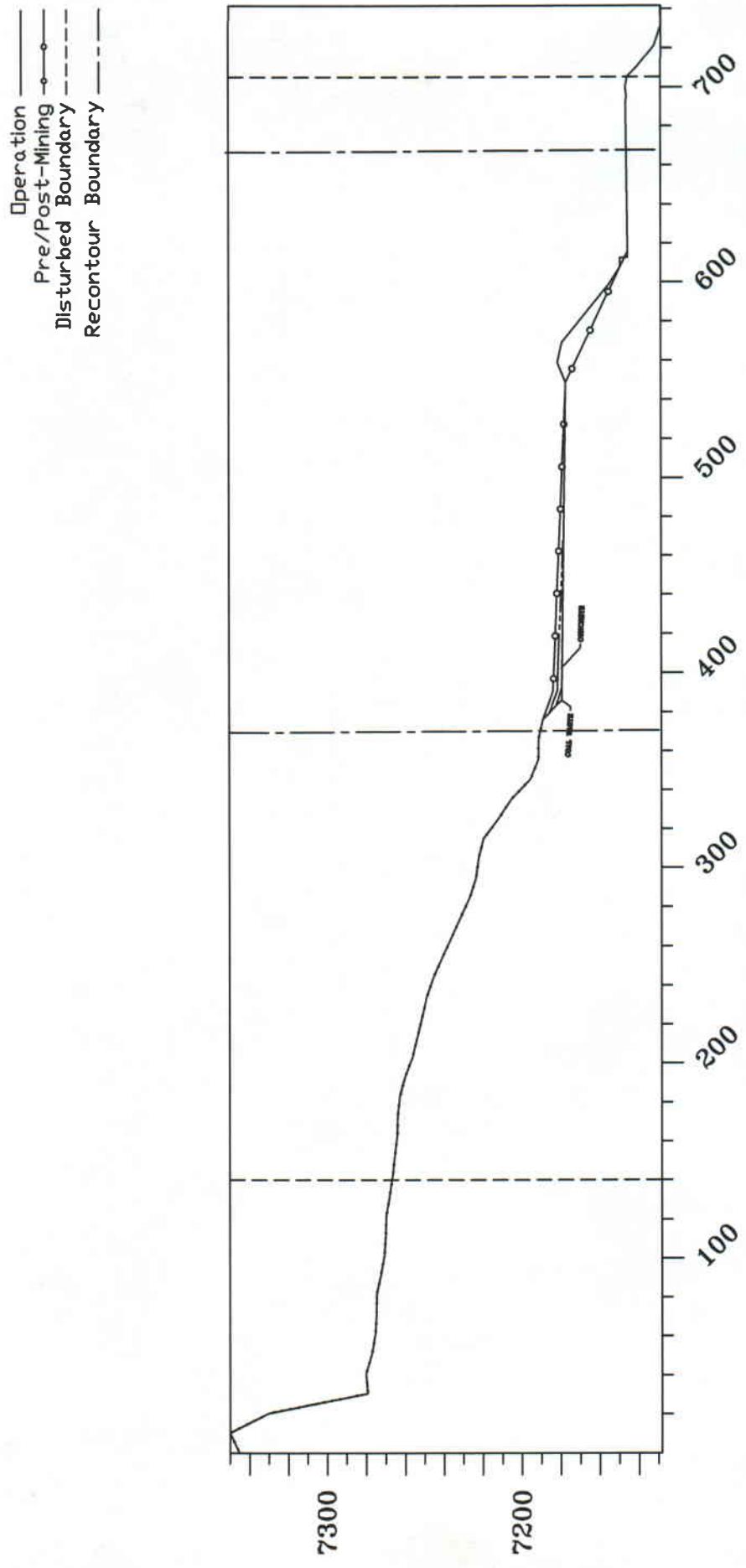
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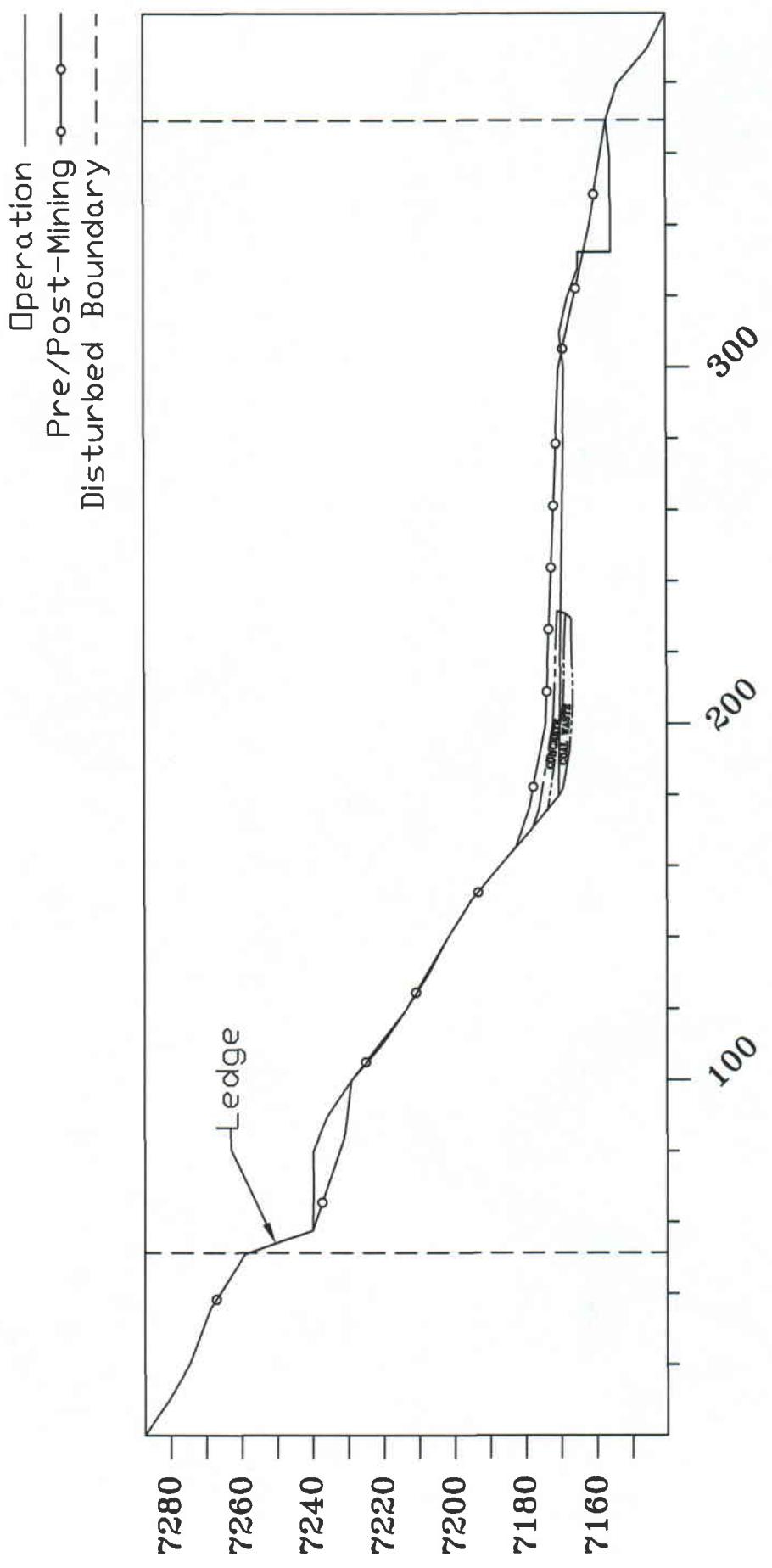
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T S-5 Section 10+00



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TS-7 Blind Seam Portal Pad

TS-7 will be reclaimed as shown on the following cross-sections in order to match the contours shown on plate 5-6C. 11,582 cu. yd. of material from either TS-5 or TS-6 will be used here for the reclamation. Three highwalls are located in this section and all of them will be completely covered with fill material. The highwall shown on section 3+00 is the belt entry and passes under the road before it enters the coal seam. Table 5I-6 show a summary of the cut and fill volumes. 678 cu. yd. of material generated during the load-out expansion is being stored in this area. This is not included in table 5I-6.

Table 5I-6 - Area TS-7 Cut & Fill Summary

Section	Fill (-) Volumes (cu. yd.)	Cut (+) Volumes (cu. yd.)			Volume Cumulative (cu. yd.)
	Total Fill Volume	Substitute Topsoil	Regular Soil	Total Cut Volume	
0+00	2,881	1,078	1,274	2,352	-529
1+00	2,633	867	718	1,585	-1,577
2+00	1,630	578	274	852	-2,355
3+00	1,356	248		248	-3,463
3+50	1,355	137		137	-4,681
4+00	1,996	45		45	-6,632
5+00	1,703	685		685	-7,650
6+00	696	67		67	-8,279
7+00	989	420		420	-8,848
7+50	443	0		0	-9,291
8+00	2,355	45	19	64	-11,582
Totals	18,037	4,170	22,207	6,455	

APPENDIX 5Q

LOAD-OUT EXPANSION

The construction of the load-out expansion will take place in eight steps. The steps are

1. Remove old culverts
2. Earthwork
3. Install retaining walls next to the coal pad.
4. Install new culverts
5. Install concrete loading pads
6. Install Road
7. Extend the belts
8. Install Sampling Station.

Figure 1 shows a plan view of the area. Below is a detailed description of each of the steps. The construction may not follow the steps exactly. Some steps may be performed currently or out of order depending on time restrictions or the need to keep the load-out operational.

Removal of old culverts

In this step a Kamatsu Track-hoe will be used to remove culverts C-4D, and C-5D. The trenches created will then be filled with road-base and ditch D-3D will be extended across the old location of C-5D forming a dirt water bar across the shop access road.

Earth work

This will start with 687 cu. yd. of material, mostly substitute topsoil, being cut from the side of the coal storage pad and hauled to TS-7 to be used in the reclamation process. Ditch D-3D will be moved up against the new pad cut.

Install retaining walls

Two retaining walls will be constructed from pre-cast blocks as shown in figure 1. The first one will be located adjacent to belt 1 and belt 3 loading points. The second one will be located adjacent to the road just north of the slack loading point. Details of the retaining walls are shown in figures 2 and

3.

Install new culverts

Trenches for the new culverts will be dug with a Track-hoe. The culverts will then be placed in the trenches and C-4D will be backfilled. On C-5D five pre-fabricated collection boxes will be installed to allow road drainage to enter the culvert. Ditch D-5D will be removed during this step and flow will be directed into Ditch D-3D.

Install concert loading pad

Three concrete pads 84' long by 12' wide be built under each of the loading hoppers to act as wear strips for the semis to stop on. The pad will start 22' in front of the loading point and extend 62' behind it. The pads will be 12" thick and will have two layers of rebar at 18" o.c. both directions. These pads will not need to be reclaimed since the will be covered by fill during reclamation.

Install road

4" of asphalt will be laid over the areas of the old and new culverts, and over the new road areas on both the right and left side of the existing road. 1 1/2" of super pave will then be laid over the entire load-out area. The road will be 75' wide creating three 20' wide lanes and one 15' wide lane. The two 20' lanes on the west side will be used for loading lanes and then will merge into 1 outlet lane. The third 20' lane will be used as an entrance lane for the trucks. The 15' lane will be and the east side and will be used for mine traffic. The 15' and 20' lanes on the east side start as one lane and then split as they enter the load-out area. Figure 1 shows a plan view of the roads. Ditch D-3D will be removed during this step.

Extend Belts

The current load-out has five conveyor belts coming out of the pad. The first three belts load bug dust for power plants, the fourth belt is not being used and the fifth belt loads oiled slack for residential use. The second belt has a cross-over belt that connects it to the first belt's loading point.

Construction will begin with the removal of the cross-over belt between the first and second belt and with the removal of the fourth belt that is not being used. Nothing will be done with the fifth (oil slack) belt. The first, second and third belts will be extended 2', 3', and 8' respectively. Figure 4 shows a typical cross-section. The second belt will load in the most western lane (lane 1) and the first and third belts will load in lane 2 (see figure 1).

Install sampling station

A small crusher will be placed on the coal storage pad above the location of the old fourth belt (removed). A drop tube will come off of the crusher with a splitter in it. One side will go down into a sampling bag and the other side will go into a waste pile. A small concrete pad will be built under the waste pile. Coal will be carried to the crusher by hand in buckets or with a bobcat.

Figure 1

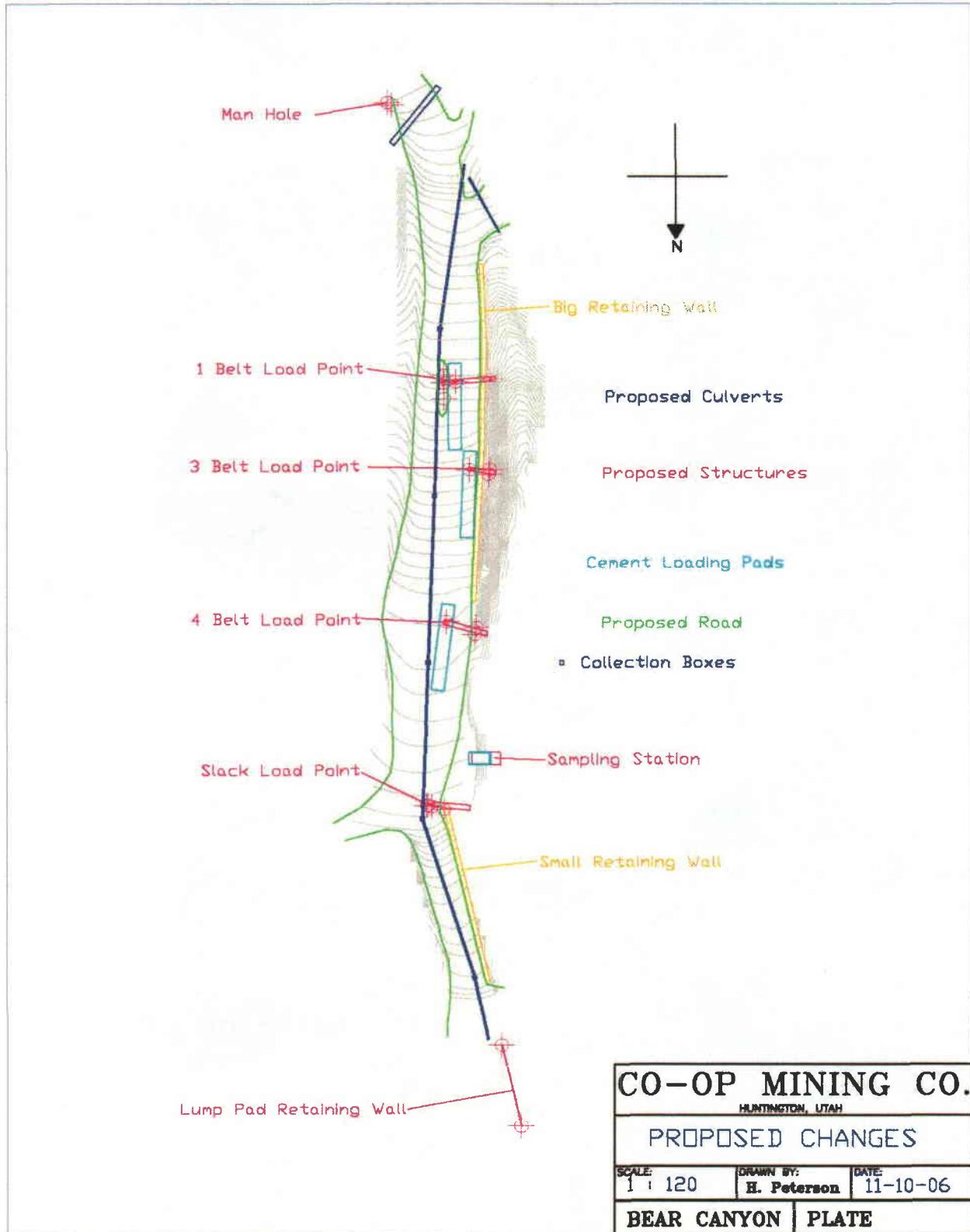


Figure 2

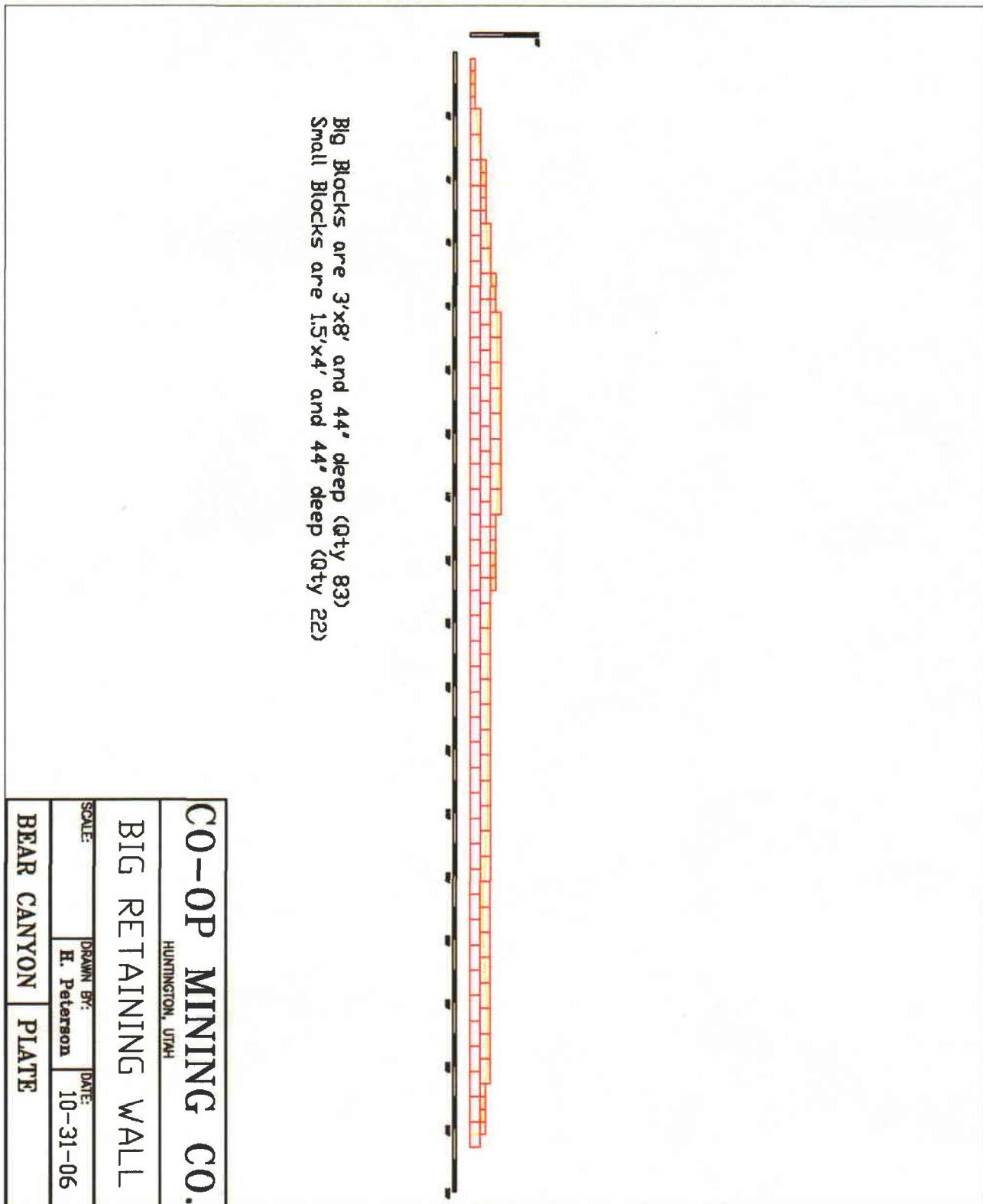


Figure 3

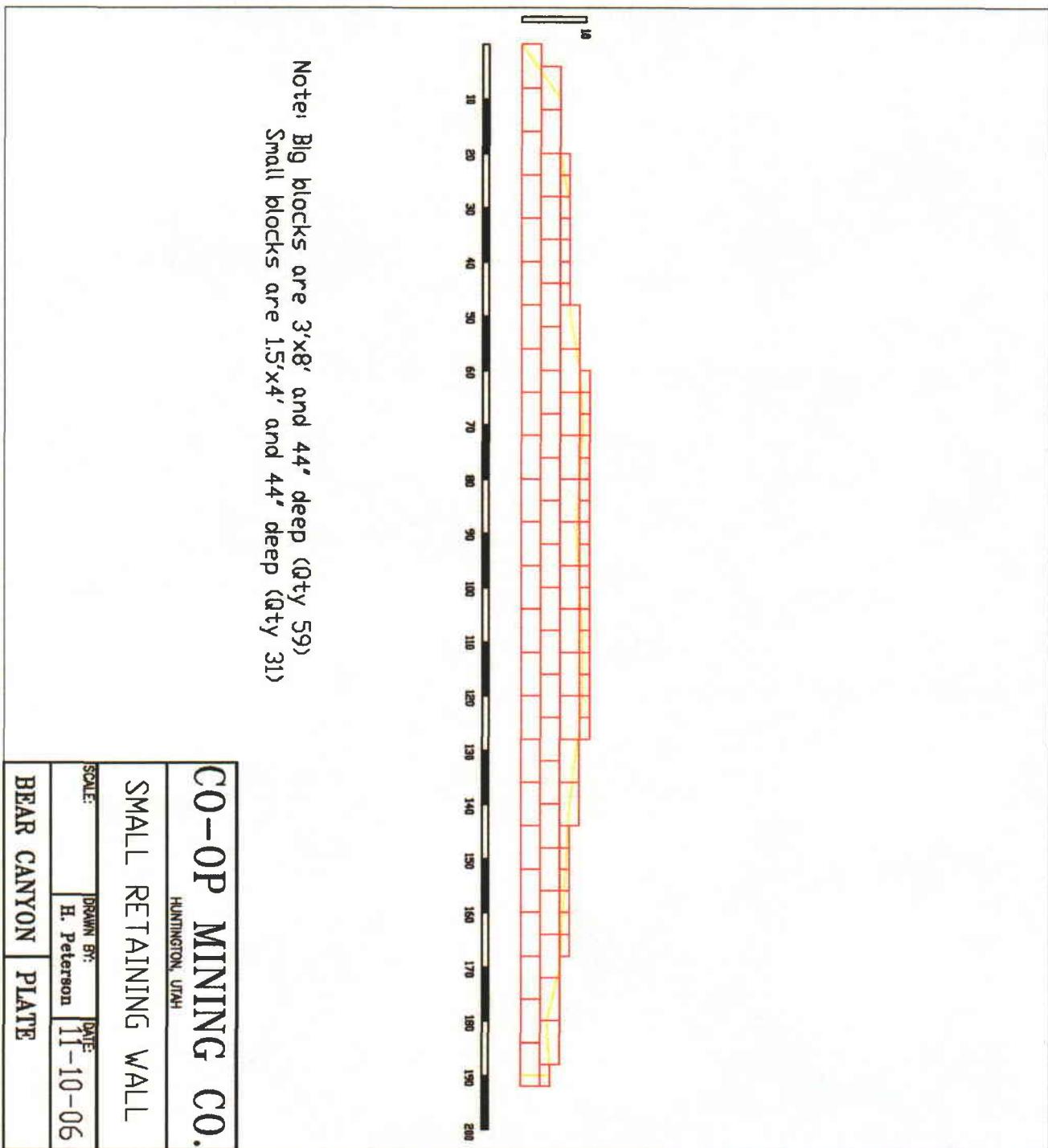


Figure 4

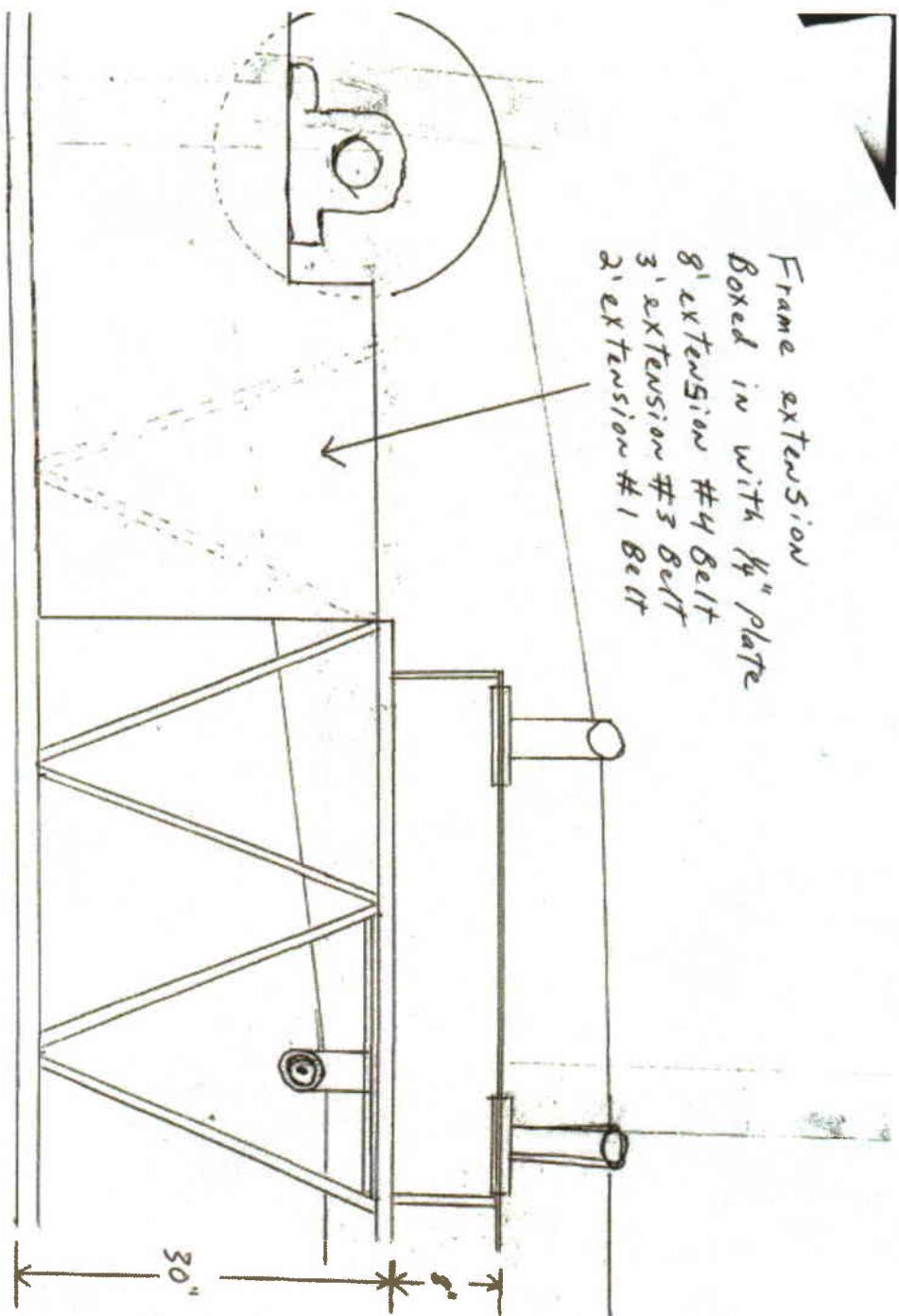


Table 7-24 Summary of Division Ditch Calculations

Ditch	Bottom Width (Ft)	Top Width (Ft)	Depth (Ft)	Type Side Slope H:V	Measured Slope %	Contributing Watershed	REQ'D Av. Rip-Rap Size (In.)
D-1D	0	1.33	0.67	1:1	2 Min 11 Max	AD-3A	Soil
D-2D	0	1.33	0.67	1:1	6 Min 20 Max	AD-3A, AD-5	Bedrock
D-3D	0	2	1	1:1	2 Min 6 Av. 18 Max	Replaced with C-5D AD-3A, AD-5, AD-7	Soil Soil Grouted
D-4D	0	2	1	1:1	2 Min 6 Av. 17 Max	AD-14	Soil Soil D_{50} 6"
D-5D	0	1.33	0.67	1:1	4 Min 10 Max	Replaced with C-5D AD-9	Soil
D-6D	0	3	1.5	1:1	2 Min 4 Max	AD-3A, AD-5 AD-7, AD-9, AD-10 AD-12, AD-14	Soil
D-7D	2	3.5	0.75	1.5:1	2 Min 6 Av. 55 Max	AD-1A, AD-1B, AD-2A AD-2B, AD-2C, AD-3B AD-4, AD-6, AD-8	Soil Soil D_{50} 6"
D-8D	0	2	1	1:1	2 Min 7 Max	AD-13	Soil
D-8D Water Bar	0	14	0.33	6:1	3 Av.	AD-13	Soil
D-9D	0	2	1	1:1	4 Min 10	AD-15	Soil
D-10D	1	3.33	0.67	1.5:1	7 Min 50	AD-6, AD-3B, (part) AD-2B, AD-2C	D_{50} 4" Bedrock
D-11D	0	1	0.5	1:1	41 Min Near Vert.	Tipple Wash Hose	Grouted Rip-Rap
D-12D	0	1	0.5	1:1	81 Av.	Tipple Wash Hose	Soil
D-13D Water Shed	0	6	0.5	10:1 2:1	0.5 Av.	AD-6 Partial	Soil
D-14D	0	1.33	0.67	1.5:1	0.06 Av.	AU-4A	Soil
D-15D	0	2.00	1.00	1:1	0.05 Av.	AD-16	Soil
D-16D	0	1.50	1.75	1:1	0.05 Av.	AD-18	Soil
D-17D	0	.96	1	1:1	0.08 Av.	AU-23, AD-20	Soil

- Notes:
- Dimensions given indicate minimum requirements. Actual dimensions may vary. Minimum required cross-sections will be maintained.
 - The use of line drainage ditches is required when flow velocities exceed approximately 5 feet per second. Rip-rap may be installed where not required.

Table 7-24 Summary of Division Ditch Calculations (Cont)

Ditch	Bottom Width (Ft)	Top Width (Ft)	Depth (Ft)	Type Side Slope H:V	Measured Slope %	Contributing Watershed	REQ'D Av. Rip-Rap Size (In.)
D-1U	2	1.33	0.67	1:1	2 Min 8 Max	AU-5	Soil
D-2U	0	1.33	0.67	1:1	7 Min 10 Max	AU-6, AU-11	Soil
D-3U	1	2	0.5	1:1	4 Min 18 Max	AU-8	Soil
D-4U	1	4	1	1.5:1	1 Min 10 Av. 18 Max	AU-10	Soil Soil D_{50} 6"
D-5U	0	1	0.5	1:1	4 Min 13 Max	AU-15	Soil
D-6U	0	1.33	0.67	1:1	3 Min 16 Max	AU-14	Soil
D-7U	0	1.33	0.67	1:1	1 Min 16 Max	AU-12	Soil
D-8U	2	4	0.67	1:1	2 Min 31 Max	AU-1, AU-1 ^a , AU-1B, AU-1C, AU-2, AU-2 ^a , AU-2B	Soil
D-9U	3	5	1	1:1	1 Min 6 Max	AU-16	Soil D_{50} 4"
D-10U	3	4	0.5	1:1	3 Min 10 Max	AU-17	Soil
D-11U	0	2	1	1:1	3 Min 8 Max	Misc. road damage	Soil
D-12U	0	3	1	1.5:1	3 Min 9 Max	AU-18	Soil D_{50} 4"
D-13U	0	2	1	1:1	2 Min 23 Max	Misc. road damage	Soil
D-14U	4	5.5	0.5	1.5:1	6 Min 66 Max	Sed Pond A Outlet	D_{50} 4" D_{50} 10"
D-15U	0	2	0.67	1.5:1	5 Min 16 Max	AU-3	Soil
D-16U	0	2	0.67	1.5:1	10 Av.	AU-1B	Soil
D-17U	0	2	0.67	1.5:1	13 Av.	AU-1 ^a	Bedrock
D-18U	0	2	0.67	1.5:1	5 Min	AU-1	Soil

Table 7-24 Summary of Division Ditch Calculations (Cont)

Ditch	Bottom Width (Ft)	Top Width (Ft)	Depth (Ft)	Type Side Slope H:V	Measured Slope %	Contributing Watershed	REQ'D Av. Rip-Rap Size (In.)
D-19U	0	2	0.67	1.5:1	6 Av.	AU-2B	Soil
D-20U	0	1.33	0.67	1:1	16 Av.	AU-42	Soil
D-21U	0	2	1.0	1:1	13 Av.	AU-43	$D_{50}=3"$
D-22U	0	3	1.0	1.5:1	11 Av.	AU-19, AU-25	$D_{50}=6"$
D-23U	0	1.16	0.58	1:1	19 Av.	AU-36	Soil
D-24U	0	1.16	0.58	1:1	14 Av.	AU-35	Soil
D-25U	0	1	0.5	1:1	16 Av.	AD-17	Soil
D-26U	0	1	0.5	1:1	24 Av.	AU-32	Soil
D-27U	0.50	2	0.5	1.5:1	13 Min, 30 Max	AU-31	Soil
D-28U	0	1	0.5	1:1	14 Av.	AU-33	Soil
D-29U	0	1.33	0.67	1:1	8 Av.	AU-34	Soil
D-30U	0	1.16	0.58	1:1	13 Av.	AU-25	Soil
D-31U	0	3	1.0	1.5:1	12 Av.	AU-20, AU-26	Bedrock
D-32U	0	1	0.5	1:1	17 Av.	AU-30	Soil
D-33U	0	1.16	0.58	1:1	18 Av.	AU-29	Soil
D-34U	1	2.74	0.58	1.5:1	11 Av.	AU-24	Soil
D-35U	0	2.0	1.0	1:1	10 Av.	AU-29	Soil
D-36	0	1.0	0.5	1:1	8 Av.	AU-27	Soil
D-37	0	1.0	0.5	1:1	8 Av.	AU-26	Soil
D-38	0	1.33	.67	1:1	12 Min, 20 Max	AU-21	$D_{50}=3"$
D-39	0	1.0	0.5	1:1	10 Av.	AU-28	Soil
D-40U	0	1.5	0.75	1:1	9 Av.	AU-24A, C-39U	$D_{50}=3$
D-41U	0	2	1	1:1	15 Av.	AU-22, AU-23A, C-40U	$D_{50}=4$
D-42U	0	0.5	0.25	1:1	36 Min, 63Max	AU-23A	Soil
D-43U	0	2	2	2:1	20 Min, 45 Max	AU-23	$D_{50}=5$

- Notes:
- Dimensions given indicate minimum requirements. Actual dimensions may vary. Minimum required cross-sections will be maintained.
 - The use of riprap to line drainage ditches is required when flow velocities exceed approximately 5 feet per second. Riprap may be installed where not required.

All calculations for the diversion ditches resulted in a maximum flow velocity of less than the maximum permissible velocity. A flow velocity of less than 5 feet per second was considered non-erosive for those ditch sections with little or no riprap or vegetation. For those ditch sections with an abundance of vegetation or riprap maximum permissible velocities were based on the channel characteristics as presented in [Appendix 7-G](#).

Fifty-three culverts have been or will be installed within the Co-Op Mine area to divert storm runoff from the disturbed and undisturbed drainage areas. These culverts were located in the field and are identified on [Plates 7-1](#).

The adequacy of the culverts to pass the design flow rate was determined. [Table 7-25](#) summarizes the culvert sizing calculations. Because the resulting HW/D (headwater depth divided by the culvert diameter) ratio is less than one for each culvert, these existing culverts will adequately pass the design storm. Culvert calculations are presented in [Appendix 7-G](#).

The slope of each culvert was measured in the field. Calculations were performed to determine the exit velocities at each culvert and the required riprap. A summary of the culvert flow velocity and riprap sizing calculations is presented in [Table 7-25](#). Culvert flow velocity computations are presented in [Appendix 7-G](#).

Where culvert exit velocities were in excess of the maximum permissible velocity, erosion protection measures were designed. These measures are presented in [Appendix 7-G](#).

Table 7-25 Culvert Characteristics

Culvert	Diameter (in.)	Type	Contributing Watersheds	Slope (ft/ft)	Outlet Condition
C-1U	30	CMP Flexible	AU-3, AU-4, AU-4A, AU-5	0.12 0.73	Bedrock
C-2U	12	stl pipe	AU-11	0.08	soil
C-3U	12	CMP	AU-6, AU-7, AU-11	0.05	4" rip-rap
C-4U	12	CMP	AU-8, AU-9	0.05	Soil
C-5U	12	CMP	AU-8, AU-9, AU-15	0.05	Soil
C-6U	12	CMP	AU-6, AU-7, AU-11 AU-13, AU-14	0.05	4" rip-rap
C-7U	12	CMP	AU-12	0.05	6" rip-rap
C-8U	18	Flexible CMP, RCP	AU-3, AU-3A AU-4, AU-4A, AU-5	0.13	12" rip-rap
C-9U	60	stl pipe	Bear Creek	0.06	48" rip-rap
C-10U	60	RCP	Bear Creek	0.06	48" rip-rap
C-11U	18	CMP	AU-16	0.10	6" rip-rap
C-12U	24	CMP	AU-17	0.04	6" rip-rap
C-13U	15	CMP	misc. road drainage	0.06	Soil
C-14U	60	CMP	Bear Creek	0.06	48" rip-rap
C-15U	18	CMP flexible	AU-1B, AU-2 AU-2A, AU-2B	0.05 0.78	27" rip-rap
C-16U	15	CMP flexible	AU-1, AU-1A	0.05 0.80	Bedrock
C-17U	12	CMP	AU-1	0.18	3" rip-rap
C-18U	15	CMP flexible	AU-2	0.05 0.75	10" rip-rap
C-19U	15	CMP flexible	AU-2A	0.05 0.75	9" rip-rap
C-20U	15	CMP flexible	AU-2B	0.05 0.75	15" rip-rap

Table 7-25 Culvert Characteristics

Culvert	Diameter (in.)	Type	Contributing Watersheds	Slope (ft/ft)	Outlet Condition
C-21U	36	CMP	Right Fork Drainage	0.06	Bedrock
C-22U	20	CMP	AU-19, AU-25	0.06	Soil
C-23U	36	CMP	AU-36, AU-35, AU-34, AU-20, AU-26, C-24U	0.06	11" rip-rap
C-24U	32	CMP	AU-40, C-25U	0.06	10" rip-rap
C-25U	30	CMP	AD-17, C-26U	0.06	8" rip-rap
C-26U	30	CMP	AU-39, AU-32, AU-33, C-30U, C-34U	0.06	8" rip-rap
C-27U	15	CMP	AU-22, AU-28, AU29A, AU-31	0.06	4" rip-rap
C-28U	15	CMP	AU-43, C-29U	0.06	4" rip-rap
C-29U	15	CMP	AU-20, AU-25, AU-26	0.06	3" rip-rap
C-30U	15	CMP	AU-21, AU-27, AU-30	0.06	Soil
C-31U	12	CMP	AU-29	0.06	Soil
C-32U	15	CMP	AU-22, AU-28, AU-29A	0.06	3" rip-rap
C-33U	24	CMP	AU-24, AU-28A, AU-37	0.06	8" rip-rap
C-34U	24	CMP	AD-19, AU-31, AU-37, AU-38, C-31U, C-32U	0.06	8" rip-rap
C-35U	84	CMP	Bear Creek	0.06	48" rip-rap
C-36U	15	CMP	AU-27, AU-21	0.11	3" rip-rap
C-37U	15	CMP	AU-21	0.31	6" rip-rap
C-38U	15	CMP	AU-28	0.08	Soil
C-39U	15	CMP	AU-22, AU-32A, C-40U	0.18	6" rip-rap
C-40U	12	CMP	AU-23	0.001	Soil

Table 7-25 Culvert Characteristics (Cont)

Culvert	Diameter (in.)	Type	Contributing Watersheds	Slope (ft/ft)	Outlet Condition	
C-1D	15	CMP flexible	AD-6, AD-3B	1.00	24" rip-rap	
C-2D	15	CMP, RCP flexible	AD-2B, AD-2C, AD-3B, AD-4, AD-6	4.0	10" rip-rap	
C-3D	20	slt pipe	AD-3A	0.03	4" rip-rap	
C-4D	21	CMP	AD-3A, AD-5, AD-7, AD-14, C-10D	0.18	9" rip-rap	
C-5D	18	CMP	AD-34, AD-5, AD-7, AD-9	0.08 0.07	Soil 3" rip-rap	
C-6D	12	CMP	AD-10	0.48	9" rip-rap	
C-7D	18	CMP	Abandoned In Place			
C-8D	18	CMP	Replaced with C-5D AD-3A, AD-5, AD-7	0.05	3" rip-rap	
C-9D	18	CMP	See C-8D	0.05	3" rip-rap	
C-10D	18	CMP	Tipple Wash Hose	0.03	Soil	
C-11D	12	CMP flexible	AD-4A	0.05 0.25	3" rip-rap	
C-12D	8	CMP	AD-18	0.05	Soil	
C-13D	12	CMP	AU-23, AD-20	0.07	Soil	

980 Loader Cycle Time

(From Cat Performance Handbook)	0.55 min
a. 3/4 inch to 6 inch	0.00 min
b. Pile (10 ft or less)	+ 0.01 min
c. 3/4 inch to 6 inch	- <u>0.04</u> min
	0.52 min

(60 min/hr)/(0.52 min/cycle) = 115.4 cycles/hr

Efficiency 50 min/hr - (115.4 cycles/hr)(6 cu yd/cycle)(50 min/60 min) = 577 cu yd/hr (96 cycles/hr)

Summary of Reclamation Cost Estimate

Direct Costs

a. Seal Portals and Backfill	\$ 112,500
b. Removal of Structures	\$ 210,403 <u>189,918</u>
c. Soil Placement and Ripping	\$ 178,617
d. Channel Restoration	\$ 403,728
e. Revegetation	\$ 462,968
f. Monitor Well Plugging	\$ 5,000

Total Direct Costs: \$ 1,373,216 1,352,731

Indirect Costs

g. Maintenance and Monitoring (10%)	\$ 137,322 <u>135,273</u>
h. Contingency (5%)	\$ 68,661 <u>67,637</u>
i. Engineering Redesign (2.5%)	\$ 34,330 <u>33,818</u>
j. Mobilization and Demobilization (5%)	\$ 68,661 <u>67,637</u>
k. Contract Management Fee (2.5%)	\$ 34,330 <u>33,818</u>

Total Indirect Costs: \$ 343,304 338,183

Total Reclamation Cost (2001 dollars) \$ 1,716,520 1,690,914

<u>Escalated Values</u>	<u>Escalation Factor</u>
2002 - 1,770,075	3.12% (est)
2003 - 1,825,302	3.12% (est)
2004 - 1,882,251	3.12% (est)
2005 - 1,940,978	3.12% (est)

The total bond currently posted, rounded to the nearest \$1,000, is \$1,825,000.

Sealehouse Area Pavement

02220-875-1750 (Pavement Removal 3")

Area = 800 1,450 square yards (1,200 at Bath-House, 174 at load-out)

Cost = (\$ 3.85 /sq yd) (800 1,374 sq yd) = \$ 3,080 5,290

Time = (800 1,374 sq yd) / (420 sq yd/day) = 1.90 3.27 days

~~Disposal at landfill~~ Asphalt will be relayed at Trail Canyon

Volume = (67 114 CY) (2 tons/yd) (1.3 swell factor) = 174 297 Tons

16 ton truck; distance to haul approx. 40 4 miles round trip = 3 8 trips/day

Time = (67 114 cu yd)/(48 128 cu yd/day) = 1.4 0.89 days

~~Dump Fee~~ = (174 Tons) (\$7.00/ton) = \$1,218

01590-200- 5300 Dump Truck Cost = (\$ 823.88/day) (1.4 1.0 days) = \$ 1,154 824

Cost Subtotal	\$ <u>5,452 6,114</u>
Time Subtotal	<u>3.3 4.2</u> days

Shower House

02220-100-0100 (Framed Portion, includes disposal)

Volume = (92 ft) (50 ft) (8 ft) = 36,800 cu ft

Cost = (\$ 0.24 /cu ft) (36,800 cu ft) = \$ 8,832

~~Dump Fee~~ = ((36,800 cu ft) / 27) (0.3 rubble volume) (1.35 tons/cy) (\$7.00/ton) = \$3,864

Time = (36,800 cu ft) / (20,100 cu ft/day) = 1.83 days

02220-100-0080 (Masonry Portion, includes disposal)

Volume = (92 ft) (50 ft) (8 ft) = 36,800 cu ft

Boot wash Volume = (12 ft) (5.5 ft) (8 ft) = 528 cu ft

Cost = (\$ 0.24 /cu ft) (37,328 cu ft) = \$ 8,959

~~Dump Fee~~ = ((37,328 cu ft) / 27) (0.3 rubble volume) (1.35 tons/cy) (\$7.00/ton) = \$3,919

Time = (37,328 cu ft) / (20,100 cu ft/day) = 1.86 days

Concrete Demolition

Foundation Volume = (0.67 ft) (2 ft) (284 ft) = (380.6 cu ft) / 27 = 14.1 cu yds

Footing Volume = (0.67 ft) (2 ft) (319 ft) = (427.5 cu ft) / 27 = 15.8 cu yds

Floor Volume = (92 ft) (50 ft) (0.33 ft) = (1518 cu ft) / (27) = 56.2 cu yds

Boot wash Floor Volume = (12 ft) (5.5 ft) (0.33 ft) = (21.8) / 27 = 0.81 cu yds

Total Volume = 86.9 cu yds

Cost = (86.9 CY) (\$12.78/CY) = \$1,111

Time = (638 s.f.) / (180 s.f./day) + (319 L.F.) / (300 L.F./day) + (4,666 s.f.) / (500 s.f./day) = 13.94 days

02220-875-5550 (Concrete Disposal on Site) 002315-400-1300 (3 CY loader) 02320-200-0320
(16 ton truck)

Volume = (86.9 CY) (1.3 swell factor) = 113.0

Cost = (113 CY) (\$10.69/CY) = \$1,208

Time = (113 cu. yds) / (232 cu. yds/day) = 0.49 days

Cost Subtotal	\$ 27,893
Time Subtotal	18.12 days

Shop

02220-100-0012 (Steel Building, includes disposal)

$$\text{Volume} = (40 \text{ ft}) (93 \text{ ft}) (14 \text{ ft}) = 52,080 \text{ cu ft}$$

$$\text{Cost} = (\$ 0.22 / \text{cu ft}) (52,080 \text{ cu ft}) = \$ 11,458$$

$$\text{Time} = 52,080 \text{ cu ft} / (21,500 \text{ cu ft/day}) = 2.42 \text{ days}$$

Concrete Demolition

$$\text{Foundation Volume} = (0.67 \text{ ft}) (4 \text{ ft}) (197.5 \text{ ft}) = (649.7 \text{ cu ft}) / 27 = 24.1 \text{ cu yd}$$

$$\text{Footing Volume} = (0.67 \text{ ft}) (2 \text{ ft}) (266 \text{ ft}) = (356.4 \text{ cu ft}) / 27 = 13.2 \text{ cu yd}$$

$$\text{Floor Volume} = (40 \text{ ft}) (93 \text{ ft}) (0.33 \text{ ft}) = (1,228 \text{ cu ft}) / 27 = 45.5 \text{ cu yd}$$

$$\text{Total Volume} = 82.8 \text{ cu. yd}$$

$$\text{Cost} = (82.8 \text{ cu yd}) (\$12.78/\text{cu yd}) = \$1,058$$

$$\text{Time} = (790 \text{ s.f.}) / (140 \text{ s.f./day}) + (266 \text{ L.F.}) / (300 \text{ L.F./day}) + (3,720 \text{ s.f.}) / (400 \text{ s.f./day}) = 9.30 \text{ days}$$

02220-875-5550 (Concrete Disposal on Site) 002315-400-1300 (3 CY loader) 02320-200-0320 (16 ton truck)

$$\text{Volume} = (82.8 \text{ cu yd}) (1.3 \text{ swell factor}) = 107.6 \text{ cu yd}$$

$$\text{Cost} = (107.6 \text{ cu yd}) (\$10.69/\text{cu yd}) = \$1150$$

$$\text{Time} = (107.6 \text{ cu yd}) / (232 \text{ cu yd/day}) = 0.46 \text{ days}$$

Cost Subtotal	\$13,666
Time Subtotal	12.18 days

Machine Shop

02220-100-0012 (Steel Building, includes disposal)

$$\text{Volume} = (30 \text{ ft}) (45 \text{ ft}) (10 \text{ ft}) = 13,500 \text{ cu ft}$$

$$\text{Cost} = (\$ 0.22 / \text{cu ft}) (13,500 \text{ cu ft}) = \$ 2,970$$

$$\text{Time} = (13,500 \text{ cu ft}) / (21,500 \text{ cu ft/day}) = 0.63 \text{ days}$$

Concrete Demolition

$$\text{Foundation Volume} = (0.67 \text{ ft}) (1 \text{ ft}) (135 \text{ ft}) = (90.5 \text{ cu ft}) / 27 = 3.4 \text{ cu yd}$$

$$\text{Footing Volume} = (0.67 \text{ ft}) (2 \text{ ft}) (150 \text{ ft}) = (201 \text{ cu ft}) / 27 = 7.4 \text{ cu yd}$$

$$\text{Floor Volume} = (30 \text{ ft}) (45 \text{ ft}) (0.33 \text{ ft}) = (445.5 \text{ cu ft}) / 27 = 16.5 \text{ cu yd}$$

$$\text{Total Volume} = 27.3 \text{ cu yd}$$

$$\text{Cost} = (27.3 \text{ cu yd}) (\$12.78/\text{cu yd}) = \$349$$

$$\text{Time} = (135 \text{ s.f.}) / (140 \text{ s.f./day}) + (150 \text{ L.F.}) / (300 \text{ L.F./day}) + (1,200 \text{ s.f.}) / (400 \text{ s.f./day}) = 4.46 \text{ days}$$

02220-875-5550 (Concrete Disposal on Site) 002315-400-1300 (3 CY loader) 02320-200-0320 (16 ton truck)

$$\text{Total Volume} = (27.3 \text{ cu yd}) (1.3 \text{ swell factor}) = 35.5 \text{ cu yd}$$

$$\text{Cost} = (\$10.69 / \text{cu yd})(35.5 \text{ cu yd}) = \$380$$

$$\text{Time} = (35.5 \text{ cu yd}) / (232 \text{ cu yd/day}) = 0.15 \text{ days}$$

Cost Subtotal	\$ 3,699
Time Subtotal	5.24 days

Sampling Station

02220-100-0012 (Steel Building, includes disposal)

$$\text{Volume} = (9 \text{ ft}) (12 \text{ ft}) (10 \text{ ft}) = 1,080 \text{ cu ft}$$

$$\text{Cost} = (\$ 0.22 / \text{cu ft}) (1,080 \text{ cu ft}) = \$ 238$$

$$\text{Time} = (1,080 \text{ cu ft}) / (21,500 \text{ cu ft/day}) = 0.04 \text{ days}$$

Concrete Demolition

$$\text{Slab Volume} = (0.5 \text{ ft}) (10 \text{ ft}) (7 \text{ ft}) = (35 \text{ cu ft}) / 27 = 1.3 \text{ cu yd}$$

$$\text{Cost} = (1.3 \text{ cu yd}) (\$12.78/\text{cu yd}) = \$17$$

$$\text{Time} = (70 \text{ s.f.}) / (400 \text{ s.f./day}) = 0.18 \text{ days}$$

02220-875-5550 (Concrete Disposal on Site) 002315-400-1300 (3 CY loader) 02320-200-0320 (16 ton truck)

$$\text{Total Volume} = 1.3 \text{ cu yd} (1.3 \text{ swell factor}) = 1.7 \text{ cu yd}$$

Cost = (\$10.69 / cu yd)(1.7 cu yd) = \$18
 Time = (1.7 cu yd) / (232 cu yd/day) = 0.01 days

Cost Subtotal	\$ 273
Time Subtotal	0.23 days

Hilfiker Pre-Fab Retaining Wall

01590-600-2500 (Crane - 25 Ton), (Flatbed Truck - 16 Ton)

Assume each piece takes 5 min. average to disassemble and load with crane.

Number of pieces = 195 pieces

Time = 195 (.17 hr) = 16 hrs

Crane + operator = (16 hrs) (\$133.72 /hr) = \$2,140

Truck + operator = (16 hrs) (\$102.99 /hr) (2) = \$3,296

CLAB = (16 hrs) (\$35.75 /hr) (2) = \$1,144

Time = 2 days

The pre-fabricated wall has a resell value of \$28,000 (2006 dollars)

02220-100-0012 (Steel Building, includes disposal)

Volume = (1,584 sq ft)(0.02 ft) = 32 cu ft

Cost = (32 cu ft) (\$0.22/cu ft) = \$7

Dump Fee = (32 / 27 cu yd) (0.3 Demolished volume) (1.35 Ton/cu yd) (\$7.00/Ton) = \$3

Time = (32) / (21,500 cu ft/day) = .01 days

Cost Subtotal	\$10 - <u>21,420</u>
Time Subtotal	.01 <u>2</u> days

Coal Processing/Crusher Facility (Tipple)

Primary Structure = 27 ft x 40 ft Approx. (25% is 25 ft high, 50% is 17 ft high, and 25% is 8 ft high.)

Secondary Structure = 20 ft x 30 ft x 51 ft high

02220-100-0012 (Steel Building, includes disposal)

Volume₁ = (27 ft)(40 ft) [(25%) (25 ft) + (50%) (17 ft) + (25%) (8 ft)] = 18,090 c.f.

Volume₂ = (20 ft)(30 ft)(51 ft) = 30,600 c.f.

Cost = (\$ 0.22 /cu ft) (48,690 cu ft) = \$ 10,712

Dump Fee = (48,690 / 27 cu yd) (0.3 Demolished volume) (1.35 Ton/cu yd) (\$7.00/Ton) = \$5,113

Time = (48,690 cu ft) / (21,500 cu ft/day) = 2.26 days

02220-100-0100 (Control House, Mixture type, includes disposal)

Volume = (12 ft)(20 ft)(10ft) = 2,400 cu ft

Cost = (\$ 0.24 /cu ft) (2,400 cu ft) = \$ 576

Dump Fee = (2400 / 27 cu yd) (0.3 Demolished volume) (1.35 Ton/cu yd) (\$7.00/Ton) = \$252

Time = (2,400 cu ft) / (20,100 cu ft/day) = 0.12 days

Concrete Demolition

Primary Structure Footings = (2 ft x 2 ft x 1.5 ft x 11) / 27 = 2.4 cu yd

Secondary Structure Footings = (3 ft x 3 ft x 2 ft x 4) / 27 = 2.6 cu yd

Primary Structure Floor = (27 ft x 40 ft x (3.5"/12)) / 27 = 11.7 cu yd

Secondary Structure Floor = (20 ft x 30 ft x (3.5"/12)) / 27 = 6.5 cu yd

Total Volume = 2.4 + 2.6 + 11.7 + 6.5 = 23.2 cu yd

Cost = (23.2 cu yd) (\$12.78/cu yd) = \$297

Time = (38 L.F.) / (300 L.F./day) + (1,680 s.f.) / (400 s.f./day) = 4.33 days

02220-875-5550 (Concrete Disposal on Site) 002315-400-1300 (3 CY loader) 02320-200-0320 (16 ton truck)

Total Volume = (23.2 cu yd) (1.3 swell factor) = 30.2 cu yd

Cost = (\$10.69 /cu. yd.) (30.2 cu yds) = \$323

Time = (30.2 cu yds) / (232 cu yds/day) = 0.13 days

Cost Subtotal	\$ 17,273
Time Subtotal	6.81 days

Conveyor Belt Tunnels

6" reinforced concrete walls, roof and floor. Dimensions = 8' W x 7' H
 Total length of tunnels = 470'

Concrete Demolition

Volume = (470 ft) [(7 ft) (2) + (8 ft) (2)] (0.5 ft) = 7,050 cu ft / 27 = 261 cu yd
 Cost = (\$12.78/cu yd) (261 cu yd) = \$3,336
 Time = (261 cu yd) / (45 cu yd/day) = 5.8 days

02220-875-5550 (Concrete Disposal on Site), 002315-400-1300 (3 CY loader), 02320-200-0320
 (16 ton truck)

Volume = 261 cu yd * 1.3 swell factor = 339 cu yd
 Cost = (\$10.69/cu yd) (339 cu yd) = \$3,624
 Time = (339 cu yd) / (232 cu yd/day) = 1.46 days

Cost Subtotal	\$6,960
Time Subtotal	7.26 Days

Power Lines & Poles

Power Pole Removal: (50 poles)(\$100/pole) = \$5,000
 Wire length: (8,700 ft) (\$11.30/100 ft) = \$983

Cost Subtotal	\$5,983
Time Subtotal	2 Days (est)

Fuel Containment Enclosure

8" reinforced concrete walls (160 ft. in length), and 6" floor.

Concrete Demolition

Volume = [(160 ft.) (2.5 ft) (.67) + (1,500 ft²) (0.5 ft) = 1018 cu ft / 27 = 38 cu yd
 Cost = (\$12.78/cu yd) (38 cu yd) = \$486
 Time = (38 cu yd) / (45 cu yd/day) = 0.84 days

02220-875-5550 (Concrete Disposal on Site), 002315-400-1300 (3 CY loader), 02320-200-0320
 (16 ton truck)

Volume = 38 cu yd * 1.3 swell factor = 49 cu yd
 Cost = (\$10.69/cu yd) (49 cu yd) = \$528
 Time = (49 cu yd) / (232 cu yd/day) = 0.21 days

Total remove structures	
Cost Total	\$ 189,918 210,403
Time Total	171.99 168.86 days

CULVERT CHARACTERISTICS (con't)

Culvert	Dia (in.)	Type	Contributing Watersheds	Peak Q(cfs)	Slope (ft/ft)	Outlet Condition
C-1D	15	CMP, flexible	AD-6, AD-3B	0.93	1.00	24" rip-rap
C-2D	15	CMP, RCP, flexible	AD-2B, AD-2C, AD-3B, AD-4, AD-6	1.47	0.40	10" rip-rap
C-3D	20	stl pipe	AD-3A	0.23	0.03	4" rip-rap
C-4D	21	CMP	AD-3A, AD-5 AD-7, AD14, C-10D	2.66	0.18	9" rip-rap
C-5D	18	CMP	AD-3A, AD-5, AD-7, AD-9	2.59 0.23	0.07 0.08	3" rip-rap soil
C-6D	12	CMP	AD-10	0.62	0.48	9" rip-rap
C-7D	18	CMP	Abandoned In Place			
C-8D	18	CMP	Replaced with C-5D AD-3A, AD-5 AD-7	2.36	0.05	3" rip-rap
C-9D	18	CMP	See C-8D	2.36	0.05	3" rip-rap
C-10D	18	CMP	TIPPLE WASH HOSE	0.25	0.03	soil
C-11D	12	CMP flexible	AU-4A	0.35 0.25	0.05 0.25	3" rip-rap
C-12D	8	CMP	AD-18	0.55	0.05	soil

Worksheet Worksheet for Circular Channel

Project Description

Worksheet	C-5D
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.024
Slope	0.070 ft/ft 000
Diameter	18 in
Discharge	2.59 cfs

Results

Depth	0.42 ft
Flow Area	0.4 ft ²
Wetted	1.68 ft
Perimeter	
Top Width	1.35 ft
Critical Depth	0.61 ft
Percent Full	28.1 %
Critical Slope	0.017184 ft/ft
Velocity	6.37 ft/s
Velocity Head	0.63 ft
Specific	1.05 ft
Energy	
Froude	2.05
Number	
Maximum	16.19 cfs
Discharge	
Discharge Full	15.05 cfs
Slope Full	0.002072 ft/ft
Flow Type	Supercritical

Minimum required riprap conditions = 3" m.d. riprap at outlet

B.C.

7G-99

1/16/07

Worksheet Worksheet for Circular Channel

Replaced with culvert C-5D

Project Description

Worksheet	C-8D
Flow-Element	Circular Channel
Method	Manning's Formula
Solve-For	Channel Depth

Input Data

Mannings Coefficient	0.024
Slope	0.060 ft/ft 000
Diameter	18 in
Discharge	2.36 cfs

Results

Depth	0.42 ft
Flow-Area	0.4 ft ²
Wetted	1.67 ft
Perimeter	
Top-Width	1.34 ft
Critical-Depth	0.58 ft
Percent Full	27.8 %
Critical-Slope	0.017029 ft/ft
Velocity	5.87 ft/s
Velocity-Head	0.54 ft
Specific	0.95 ft
Energy	
Froude	1.89
Number	
Maximum	14.09 cfs
Discharge	
Discharge-Full	13.94 cfs
Slope-Full	0.001721 ft/ft
Flow-Type	Supercriti cal

~~Minimum required riprap conditions = 3" m.d. riprap and outlet~~

B.C.

7G-102

1/16/07

DITCH CHARACTERISTICS

DITCH	CHANNEL SLOPE %	CONTRIBUTING WATERSHED	PEAK Q(cfs)	BANK AND BOTTOM DESC.	MANNING'S $\eta^{(a)}$
D-1D	2 Min, 11 Max	AD-3A	0.23	Rocky Soil	0.03
D-2D	6 Min, 20 Max	AD-3A, AD-5	0.53	Rocky Soil, Bedrock	0.03
D-3D	2 Min, 6 Av 14 Max	Replaced with C-5D AD-3A, AD-5, AD-7	2.36	Soil, grouted half round culvert	0.03
D-4D	2 Min, 7 Av 17 Max	AD-14	0.05	Soil	0.03
D-5D	4 Min, 10 Max	Replaced with C-5D AD-9	0.23	Soil	0.03
D-6D	2 Min, 4 Max	AD-3A, AD-5, AD-7 AD-9, AD-10, AD-12 AD-14	3.63	Rocky Soil	0.03
D-7D	2 Min, 6 Av 55 Max	AD-1A, AD-1B, AD-2A AD-2B, AD-2C, AD-3B AD-4, AD-6, AD-8	4.90	Soil $D_{50} \approx 3"$	0.03 0.033
D-8D	2 Min, 7 Max	AD-13	1.23	Soil	0.03
D-8D Water Bar	3 Av.	AD-13	1.23	Soil	0.013
D-9D	4 Min, 10 Max	AD-15	1.20	Soil	0.03
D-10D	7 Min, 50 Max	AD-6, AD-3B, AD-2C	1.03	$D_{50} \approx 4"$	0.033
D-11D	41 Min Near Vertical Max	TIPPLE WASH HOSE	0.25	Grouted rip-rap	0.035
D-12D	81 Av.	TIPPLE WASH HOSE	0.25	Grouted	0.03
D-13D Water Bar	0.5 Av.	AD-6 Partial	0.23	Soil	0.03
D-14D	0.06 Av.	AU-4A	0.35	Soil	0.03
D-15D	0.05 Av.	AD-16	1.24	Soil	0.03
D-16D	0.05 Av.	AD-18	0.55	Soil	0.03
D-17D	0.08	AU-23,AD-20	0.99		

Worksheet Worksheet for Trapezoidal Channel

Replaced with C-5D

Project Description

Worksheet	DITCH D-3D
Flow Element	Trapezoidal
	Channel
Method	Manning's
	Formula
Solve For	Channel
	Depth

Input Data

Mannings Coefficient	0.030
Slope	0.020 ft/ft
	0.00
Left Side Slope	1.00 V:
	H
Right Side Slope	1.00 V:
	H
Bottom Width	0.00 ft
Discharge	2.36 cfs

Results

Depth	0.86 ft
Flow Area	0.7 ft ²
Wetted Perimeter	2.44 ft
Top Width	1.72 ft
Critical Depth	0.84 ft
Critical Slope	0.02815 ft/ft
	1
Velocity	3.17 ft/s
Velocity	0.16 ft
Head	
Specific Energy	1.02 ft
Froude Number	0.85
Flow Type	Subcritical
	at

Use Minimum Depth = 1 ft
 Velocity < 5 fps
 At Steep Slope 18%

Minimum Freeboard = 0.14 ft
 No rip rap required
 Grouted half ground culvert

B.C.

7G-115

1/16/07

Worksheet Worksheet for Trapezoidal Channel

Replaced with C-5D

Project Description

Worksheet	DITCH D-3D (Avg Slope)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.030
Slope	0.060 ft/ft 000
Left Side Slope	1.00 V: H
Right Side Slope	1.00 V: H
Bottom Width	0.00 ft
Discharge	2.36 cfs

Results

Depth	0.70 ft
Flow Area	0.6 ft ²
Wetted	1.99 ft
Perimeter	
Top Width	1.40 ft
Critical Depth	0.84 ft
Critical Slope	0.028151 ft/ft
Velocity	4.79 ft/s
Velocity	0.36 ft
Head	
Specific Energy	
Froude Number	1.43
Flow Type	Supercritical

B.C.

7G-116

1/16/07

Worksheet Worksheet for Trapezoidal Channel

Replaced with C-5D

Project Description

Worksheet	DITCH D-3D (Max Slope)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.030
Slope	0.180 ft/ft 000
Left Side Slope	1.00 V: H
Right Side Slope	1.00 V: H
Bottom Width	0.90 ft
Discharge	2.36 cfs

Results

Depth	0.57 ft
Flow Area	0.3 ft ²
Wetted Perimeter	1.62 ft
Top Width	1.14 ft
Critical Depth	0.81 ft
Critical Slope	0.028154 ft/ft
Velocity	7.23 ft/s
Velocity	0.81 ft
Head	
Specific Energy	1.38 ft
Froude Number	2.39
Flow Type	Supercritical

B.C.

7G-117

1/16/07

Worksheet Worksheet for Trapezoidal Channel

Replaced with C-5D

Project Description

Worksheet	DITCH D-5D
Flow Element	Trapezoidal
Channel	
Method	Manning's
Formula	
Solve For	Channel
	Depth

Input Data

Mannings Coefficient	0.030
Slope	0.040 ft/ft
	000
Left Side Slope	1.00 V:
	H
Right Side Slope	1.00 V:
Slope	H
Bottom Width	0.00 ft
Discharge	0.23 cfs

Results

Depth	0.32 ft
Flow Area	0.1 ft ²
Wetted	0.89 ft
Perimeter	
Top Width	0.63 ft
Critical Depth	0.32 ft
Critical Slope	0.038399 ft/ft
Velocity	2.30 ft/s
Velocity	0.08 ft
Head	
Specific Energy	0.40 ft
Froude Number	1.02
Flow Type	Supercritical

Use Minimum Depth = 0.67 ft
Velocity < 5 fps

Minimum Freeboard = 0.34 ft
No rip rap required

B.C.

7G-120

1/16/07

Worksheet

Worksheet for Trapezoidal Channel

Replaced with C-5D

Project Description

Worksheet	DITCH D-5D (Max Slope)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.030
Slope	0.100 ft/ft 000
Left Side Slope	1.00 V: H
Right Side Slope	1.00 V: H
Bottom Width	0.00 ft
Discharge	0.23 cfs

Results

Depth	0.27 ft
Flow Area	0.1 ft ²
Wetted Perimeter	0.75 ft
Top Width	0.53 ft
Critical Depth	0.32 ft
Critical Slope	0.038400 ft/ft
Velocity	3.24 ft/s
Velocity	0.16 ft
Head	
Specific Energy	0.43 ft
Froude Number	1.67
Flow Type	Supercritical

B.C.

7G-121

1/16/07